

CERAMIC FLAME DAMPER

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The results of studying ceramic mixtures for high-temperature porous ceramics are considered. The technology of producing a flame damper based on such mixture is analyzed.

During operation of a plant for detonation spraying of coatings, a situation may arise in which the flame of a microexplosion inside the work chamber propagates in a direction that was not intended, i.e., propagates along the gas-conducting flues. To stop the combustion and to prevent an emergency situation, a flame damper is installed in the plant. In principle, this is a porous partition installed on the path of the moving gas flows. The pores have to be open and interconnecting. Their sizes are selected in a way to ensure transmission of a prescribed quantity of gas into the work chamber, as well as extinguishing the flame moving in the opposite direction.

One of the designs of a flame damper constitutes a hollow cylinder with outer diameter 60 mm, inner diameter 50 mm, and height 60 mm. The cylinder is made by compression from metallic titanium powder. According to the current technical standards, such articles should have a pore size not greater than 40 μm and ensure transmission of gas at 6 liters/min at a pressure difference 1 kPa. However, operation plants demonstrated that such a flame damper has a significant drawback: despite its high cost, it relatively soon breaks down due to local fusions of the metal. Therefore, we studied and developed a ceramic flame damper free of the specified drawback. Taking into account the specific properties of ceramics, the wall thickness of the flame damper was doubled at the expense of decreasing the inner diameter.

The following techniques were used to obtain and control the required values of open porosity [1, 2]: fractional selection of initial material particles with their subsequent contact consolidation, introduction of burning-out additives, and development of conditions for formation of shrinkage microcracks.

The initial materials included powder of a prescribed granulometric composition obtained by milling chamotte brick, coal (the burning-out additive), high-melting clay, and faience glaze frit. Chamotte grains were intended for the formation of a spatial frame with tortuous open channels, and

frit was used to ensure liquid-phase sintering of these grains into a strong lattice monolith. As for clay, it was assumed that it would act as a plastifier and a binder at the molding stage, produce shrinkage cracks in drying, and in combination with frit act as a cementing binder in firing.

The raw materials were separately milled and sifted in the air-dry state, and the clay (to achieve the most uniform distribution in the mixture) was introduced in the form of a finely milled aqueous suspension. The coal and the frit were milled until passing through a sieve with cell size 10,000 cells/cm² without a residue, and the chamotte used had three fractions: 0.50–0.25, 0.25–0.14, and 0.14–0.05 mm.

Samples were molded by semidry compression at pressure 8.5 MPa, and after drying fired at 1300°C with 2 h exposure at this temperature. The pore size was found by investigating the surface of a polished section of the sample with a measuring microscope.

Several batches of experimental mixtures were prepared, in which the content of every batch component varied in such a way as to obtain the fullest possible information on its effect on the type and the size of pores. At the first stage, the effect of the burning out additive (coal) was evaluated. The compositions of coal-bearing mixtures is given in Table 1.

Analysis of the porous structure of samples of mixtures 1 and 2 demonstrates that as the coal content increases, the

TABLE 1

Component	Weight content, parts, in samples of mixture*	
	1	2
Vladimirovskoe clay	15	15
Chamotte of fraction, mm:		
0.50–0.25	40	40
0.25–0.14	20	–
0.14–0.05	–	20

* Samples of both mixtures contained 10 parts of frit and 0–18 parts of coal.

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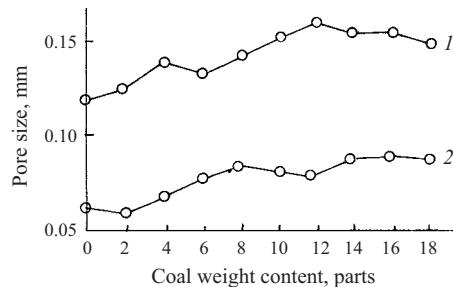


Fig. 1. Variation in the pore size depending on the quantity of burning-out additive in samples of mixtures 1 and 2.

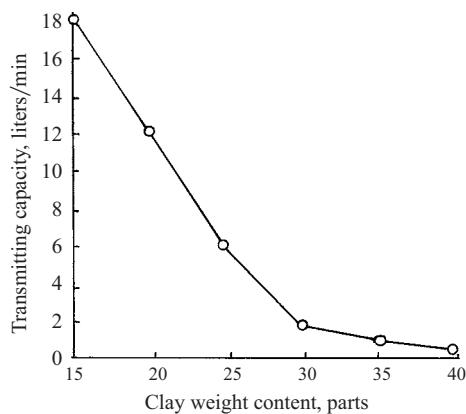


Fig. 2. Transmitting capacity of samples depending on the clay content.

maximum pore size proportionately grows. However, the total content of pores was lower in samples of mixture 2 (Fig. 1). This can be accounted for by the fact that a combination of the coarse and fine chamotte fractions in the absence of the medium-size fraction ensures a more uniform distribution of the burning-out component. However, the capacity of samples of both mixture 1 and mixture 2 for trans-

mitting gas was well above the requirements of the technical standards. Therefore, in further experiments the burning-out additive and chamotte fraction of 0.14–0.05 mm were excluded from the batch composition, and it was assumed that the size and number of pores could be controlled via the finest-disperse component, namely, clay.

The experiments were conducted with the following batch composition (weight parts): 15–40 Vladimirovskoe clay, 40 chamotte of 0.50–0.25 mm fraction, 20 chamotte of 0.25–0.14 mm fraction, and 10 glaze frit. The transmitting capacity of the samples of this mixture is shown in Fig. 2. It can be seen that the composition with 25 parts of clay satisfies the required conditions with respect to its transmitting capacity. It was found that the maximum pore size in this case is 40–50 μm . Since the wall thickness and, consequently, the channel length are doubled compared with the titanium flame damper, we regard this value as meeting the requirements.

The performance of a series of flame dampers made of a mixture of the specified composition demonstrated that the aim of the present study has been achieved and these articles fully meet the prescribed requirements. The relatively simple technology described above makes it possible to obtain a refractory, chemically resistant, and inexpensive porous material, whose capacity for transmitting gas can be regulated within a wide interval. The proposed method can be also used for the development of a highly efficient monoblock or granulated catalyst carrier for after-burning of exhaust gas from internal combustion engines.

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